

Claims

1. A method for automatic adjustment of devices having
5 setting elements, characterized in that the adjustment
comprises the following steps:

- 10 a) Carrying out a first measurement of a
characteristic curve to be controlled by the
adjustment at predefined measurement points, the
or each setting element assuming a first setting,
the "reference setting",
- 15 b) testing a termination condition and terminating
the method if this condition is satisfied,
executing the following steps if the termination
condition is not satisfied,
- 20 c) modifying the reference setting of a setting
element and measuring the characteristic curve
again at predefined measurement points for this
configuration setting element configuration,
- 25 d) reproducing the initial reference setting of the
setting element modified in step c),
- e) when there is more than one setting element,
repeating the steps c) and d) for each setting
element,
- 30 f) calculating the gradient functions of the
characteristic curve,

- 18 -

- g) calculating new settings of the setting elements by minimizing an error function by using the measured values obtained in steps a) and c) and the gradient functions calculated in step f),
- 5 - setting the elements to the calculated values,
- h) carrying out the method again, beginning with step a), the settings calculated in step g) serving as the new "reference setting".

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2. A method according to Claim 1, characterized in that the starting reference setting of the setting elements at the beginning of the method

- 15 - is assumed in the middle of the respective setting range of a setting element or
- is predefined by means of values from experience or
- is determined by a preliminary adjustment method.

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3. A method according to any preceding claim, characterized in that after each measurement of the characteristic curve, a test of the termination condition is carried out and the method is terminated

25 if this condition is satisfied.

4. A method according to any preceding claim, characterized in that the test of the termination condition comprises an automatic comparison between the

30 measured values of the characteristic curve and predefinable desired values or desired ranges.

- 19 -

5. A method according to any preceding claim, characterized in that the measurement of the characteristic curve is carried out as a

- 5 - scalar or
- vectorial

measurement.

10 6. A method according to any preceding claim, characterized in that, in order to minimize the error function in step g) of the method according to Claim 1,

- a gradient method and/or
- 15 - a random method

is used.

7. A method according to any preceding claim,
20 characterized in that the minimization of the error function in step g) of the method according to Claim 1 is terminated

- if, at one of the measurement points, the
25 difference between the last determined theoretical value of the characteristic curve and the measured value of the characteristic curve assumes or exceeds a first predefinable magnitude (ΔS_{llmax}) for the corresponding setting of the
30 setting elements or

- if at one of the measurement points the difference between the last determined theoretical setting and the corresponding setting of the setting

- 20 -

elements assumes or exceeds a second predefinable magnitude ($\Delta E_{E_{max}}$) or

5 - if in a set of predefinable measurement points the last determined theoretical values of the characteristic curve have reached a predefinable desired value or desired range or

10 - if in a set of predefinable measurement points the difference between theoretical values, determined in successive steps of the minimization method, of the predefinable measurement points assumes or falls below a third predefinable magnitude.

15 8. A method according to Claim 7, characterized in that

- the predefinable magnitudes and/or
- the predefinable measurement points

20 for each device to be adjusted are determined individually by means of test measurements.

25 9. A method according to Claim 7 or 8, characterized in that the theoretical values of the characteristic curve are determined by calculating a linear approximation function of the characteristic curve.

30 10. A method according to any preceding claim, characterized in that the gradient of a characteristic curve (f) is determined in accordance with the following rule:

$$f_{\text{Gradient}}(a, i) = df(a, i)/dEE(i)$$

- 21 -

$$= \frac{(f(a,i,1) - f(a,i,0))}{(EE(i,1) - EE(i,0))},$$

5 where: i = number of the setting element,
 a = parameter,
 EE = setting element,
 EE(i,0) = position of the setting
 10 element No. i before the
 modification of the reference
 setting,
 EE(i,1) = position of the setting
 element No. i after the
 modification of the reference
 setting,
 15 f(a,i,0) = f before the modification of
 the reference setting of the
 setting element No. i,
 f(a,i,1) = f after the modification of
 the reference setting of the
 20 setting element No. i.

11. A method according to any preceding claim,
 characterized in that for a characteristic curve which,
 in addition to the setting of the setting elements,
 25 depends on further variable parameters, for each
 configuration of the setting elements, a measurement of
 the characteristic curve for a plurality of measurement
 points is carried out, each parameter assuming a
 plurality of different values.

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12. A method according to any preceding claim,
 characterized in that the number of measurement points
 corresponds to the number of setting elements.

- 22 -

13. A method according to any preceding claim, characterized in that the device to be adjusted by means of adjustment is designed as a microwave filter.

5 14. A method according to Claim 13, characterized in that for each configuration of the adjusting elements of a microwave filter, a measurement of the characteristic curve is carried out for a plurality of measurement points, the frequency, as parameter,
10 assuming a plurality of different values.

15 15. A method according to Claim 13 or 14, characterized in that the measurement points are distributed uniformly only over the filter forward pass range.

16. A method according to any of Claims 13 to 15, characterized in that the characteristic curve to be controlled describes

20 - the reflection factor (S_{11}) and/or
- the S_{12} parameter and/or
- the S_{21} parameter and/or
- the S_{22} parameter

25 of a microwave filter.

17. A method according to any preceding claim, characterized in that the calculation of new settings of the setting elements in step g) of the method
30 according to Claim 1 is carried out by the theoretical behaviour of each individual measurement point in the event of a simultaneous change in all the setting elements being simulated by means of linear superposition.

18. An arrangement having a processor which is set up in such a way that a method for automatic adjustment of devices having setting elements can be carried out, the
5 adjustment comprising the following steps:

- 10 a) Carrying out a first measurement of a characteristic curve to be controlled by the adjustment at predefined measurement points, the setting elements assuming a first setting, the "reference setting",
- 15 b) testing a termination condition and terminating the method if this condition is satisfied, executing the following steps if the termination condition is not satisfied,
- 20 c) modifying the reference setting of a setting element and measuring the characteristic curve again at predefined measurement points for this configuration of the setting elements,
- 25 d) reproducing the initial reference setting of the setting element modified in step c),
- e) in the presence of a plurality of setting elements, repeating the steps c) and d) for each setting element,
- 30 f) calculating the gradient functions of the characteristic curve,
- g) calculating new settings of the setting elements by minimizing an error function by using the

- 24 -

measured values obtained in steps a) and c) and the gradient functions calculated in step f),
- setting the elements to the calculated values,

- 5 h) carrying out the method again, beginning with step a), the settings calculated in step g) serving as the new "reference setting".

19. A computer program product, which comprises a
10 computer-readable storage medium on which a program is stored which, after it has been loaded into the memory of a computer, makes it possible for the computer to carry out a method for automatic adjustment of devices having setting elements, the adjustment comprising the
15 following steps:

- a) Carrying out a first measurement of a characteristic curve to be controlled by the adjustment at predefined measurement points, the
20 setting elements assuming a first setting, the "reference setting",
- b) testing a termination condition and terminating the method if this condition is satisfied,
25 executing the following steps if the termination condition is not satisfied,
- c) modifying the reference setting of a setting element and measuring the characteristic curve
30 again at predefined measurement points for this configuration of the setting elements,
- d) reproducing the initial reference setting of the setting element modified in step c),

- e) in the presence of a plurality of setting elements, repeating the steps c) and d) for each setting element,
- 5 f) calculating the gradient functions of the characteristic curve,
- 10 g) calculating new settings of the setting elements by minimizing an error function by using the measured values obtained in steps a) and c) and the gradient functions calculated in step f),
- setting elements to the calculated values,
- 15 h) carrying out the method again, beginning with step a), the settings calculated in step g) serving as the new "reference setting".
- 20 20. A computer-readable storage medium, on which a program is stored which, after it has been loaded into the memory of a computer, makes it possible for the computer to carry out a method for automatic adjustment of devices having setting elements, the adjustment comprising the following steps:
- 25 a) Carrying out a first measurement of a characteristic curve to be controlled by the adjustment at predefined measurement points, the setting elements assuming a first setting, the
- 30 "reference setting",
- b) testing a termination condition and terminating the method if this condition is satisfied,

- 26 -

executing the following steps if the termination condition is not satisfied,

- 5 c) modifying the reference setting of a setting element and measuring the characteristic curve again at predefined measurement points for this configuration of the setting elements,
- 10 d) reproducing the initial reference setting of the setting element modified in step c),
- 15 e) in the presence of a plurality of setting elements, repeating the steps c) and d) for each setting element,
- 20 f) calculating the gradient functions of the characteristic curve,
- g) calculating new settings of the setting elements by minimizing an error function by using the measured values obtained in steps a) and c) and the gradient functions calculated in step f),
 - setting the elements to the calculated values,
- 25 h) carrying out the method again, beginning with step a), the settings calculated in step g) serving as the new "reference setting".